AIR SERVICE INFORMATION CIRCULAR

(AVIATION)

PUBLISHED BY THE CHIEF OF AIR SERVICE, WASHINGTON, D. C.

Vol. IV September 15, 1922 No. 303 (Addendum)

ADDENDUM TO INFORMATION CIRCULAR, VOL. IV NO. 303, DISCUSSION OF AIRPLANE TIRES AND WHEELS

(MATERIAL SECTION REPORT)

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McCook Field, Dayton, Ohio

July 27, 1922

WASHINGTON
GOVERNMENT PRINTING OFFICE
1922

CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

ADDENDUM TO INFORMATION CIRCULAR, VOL. IV, NO. 303—DISCUSSION OF AIRPLANE TIRES AND WHEELS.

PURPOSE.

To determine the load per square inch of tire contact on the supporting surface and its relation to the supporting load and tire inflation.

CONCLUSIONS.

The load which a tire will carry depends upon the area of contact and the inflation pressure, and is equal to the product of the area in square inches by the inflation pressure in pounds per square inch. The area of contact is the same for equal tire deflections regardless of the inflation pressure, but the load carried by the tire will be greater for the same area of contact as the pressure is increased.

The deflection of the tire is principally a flattening of the tread, and bears a simple mathematical relation to the area of contact. The area of contact is an ellipse equal to $\frac{\pi A B}{4}$, in which A and B are the major and minor axes of the ellipse. The length of these axes can be approximated closely from the formula for the chord subtended by the arc of the segment of a circle. The length of the chord is equal to twice the square root of the deflection multiplied by the difference between the diameter and the deflection, or

$$A=2\sqrt{h\,(d-h)}$$

d for the major axis is equal to the outside diameter of the wall and tire. d for the minor axis is equal to the diameter of the tire.

The loads for the 54 by 12 tire calculated on this basis for a 50 per cent deflection of the tire would be 10,000, 12,000, and 14,000 pounds for 50, 60, and 70 pounds per square inch inflation pressures, respectively.

APPARATUS.

The standard wheel and tire test rig was used in all cases, with the following change: A sheet of paper was placed between the tire and the supporting surface. Powdered soapstone was scattered on the paper to permit of obtaining the contact diagram of the tire when the load was applied. These contact diagrams were obtained for inflation pressures of 50 and 65 pounds and for tire deflections of 25 and 50 per cent.

MATERIALS.

The wheels and tires used were the new straight-side type of the following sizes: 28 by 4, 32 by 6, 36 by 8, and 44 by 10.

PROCEDURE.

The wheels with inflated tires mounted on them were mounted on the stationary head of an Olsen testing machine. Soapstone was scattered on paper between the supporting surface and the tire to record the diagram of tire contact with supporting surface. The contact diagram of each tire was obtained for deflections of 25 and 50 per cent at inflation pressure of 50 and 65 pounds. The area of the tire contact diagrams was obtained by means of a planimeter, and the pressure per square inch on the diagram was obtained from the load supported by the tire and the area of the diagram.

RESULTS OF TESTS.

Table 1 gives the results of tests and calculations obtained in this series of experiments.

In the case of airplane tires subjected to load there is always an increase in the inflation pressure as a result of tire deflection. While this increase is never very large, it is a measurable quantity, and the following table shows the general tendencies of pressure change in the several tires tested:

Size.	Initial pressure.	Pressure at 50 per cent deflection.
28 x 4	65	70
32 x 6	60	65
36 x 8	50	55
36 x 8	60	65
44 x 10	65	70

In Table 1 the column next to last is headed "Load recommended in designers' handbook." This value is obtained from the load-deflection curves for each size tire at the deflection and inflation pressures noted. The last column is the load per square inch calculated from area of contact diagram and the recommended loads. It can be seen that the calculated or service pressures are almost identical to those obtained in the laboratory, and these pressures are not excessive and are well within the working limits of the tire.

DISCUSSION OF RESULTS.

It will be seen from Table 1 that the load per square inch of contact on the supporting surface, as determined by the contact diagram, is the same as the inflation pressure of the tire. The load per inch of tread width is con-

siderably higher for high inflation pressures than for low pressures and varies with the different sizes of tires. It is not a satisfactory basis for calculating the load which a tire will carry.

The last two columns in Table 1 are included for general consideration. Previous to the laboratory determinations as obtained above, it was felt that it was necessary to indicate a "maximum allowable plane weight per wheel" for the guidance of designers. These limits were chosen from the load-deflection curves previously developed in this report, after deciding in a more or less arbitrary way that a normal tire deflection of approximately 20 per cent would permit of satisfactory tire performance.

It will be seen that the load per square inch of contact diagram area calculated from these maximum loading limits for designers checks very closely with the loading per square inch of contact diagram area as determined in the laboratory.

TABLE 1.

Tire.	Air pressure (pounds).	Deflection (per cent).	Load, (pounds).	Area contact diagram (square inches).	Short axis of diagram (inches).	Load per inch tread width (pounds).	Load per square inch contact area (pounds).	Load recommended in designers' handbook.	Load per square inch, recommended.
28 x 4	50	25	1,300	23.4	3.0	433	55.5	1,200	51.5
28 x 4	50	50	2,400	45.1	4.6	520	53.5	2,400	53.5
28 x 4	65	25	1,560	23.1	3,4	462	67.5	1,600	69.0
28 x 4	65	50	2,900	44.0	4.5	645	66.0	3,400	77.0
32 x 6	50	25	2,200	43.0	4.4	503	50.0	2,000	46.5
32 x 6	50	50	4,700	87.0	6.9	684	54.0	4,500	52.0
32 x 6	65	25	2,600	39.3	4.3	612	66.2	2,500	63.0
32 x 6	65	50	6,000	86.3	6.4	942	69.5	5,500	64.0
36 x 8	50	25	3,600	69.4	6.6	544	52.0	3,500	50.5
36 x 8	50	50	8,000	136.9	8.9	900	58.5	7,200	52.5
36 x 8	65	25	4,900	73.5	6.6	740	66.6	4,000	55.0
36 x 8	65	50	10,000	140.6	9.0	1,120	71.2	8,750	62.0
44 x 10	50	25	5,000	93.4	7.1.	704	53.5	6,000	65.0
44 x 10	50	34	8,320	150.2	9.1	913	55.5	9,000	60.0